

REMARKS

By this Amendment, Claim 12 has been cancelled without prejudice to or disclaimer of the subject matter contained therein, and Claims 7, 9, 10, 41, 42 and 49 have been amended. Claims 1-11, 13-15 and 39-61 are pending in the application. Reconsideration of the September 9, 2004 Official Action is respectfully requested in view of the following remarks.

Rejection Under 35 U.S.C. § 112, First Paragraph

Claims 42, 48-50, 55 and 61 stand rejected under 35 U.S.C. § 112, first paragraph. The reasons for the rejection are stated on page 2 of the Official Action.

Claim 42 has been amended to delete the term "optional."

Regarding Claim 49, the Official Action asserts that the specification does not describe "the total number of the off-axis outlets being 8," as claimed. Although Applicants disagree with this assertion, in order to expedite prosecution, Claim 49 has been amended to recite that "the off-axis outlets are circumferentially spaced apart from each other by 120°, 90° or 45°." Support for the amendment to Claim 49 is provided at page 14, lines 6-11 of the specification.

Regarding Claim 50, the Official Action asserts that the specification does not describe that "the common gas supply comprises a single third gas line in fluid communication with the first gas line and the second gas line," as claimed. Applicants disagree with this assertion.

FIG. 2a, for example, shows an embodiment of a gas injector comprising a "first gas line" in which flow controller 36a is placed, a "second gas line" in which flow controller 36b is placed, and a single "third gas line" 32 in fluid communication with

the first and second gas lines. See page 12, lines 1-11 of the specification.

Applicants submit that this description provides a sufficient written description of the subject matter recited in claim 50 to comply with the requirements of 35 U.S.C. § 112, first paragraph.

Furthermore, as explained at MPEP § 2163(II)(3)(a), at the paragraph bridging pages 2100-170 to 2100-171, “[a]n applicant may show possession of an invention by disclosure of drawings ... that are sufficiently detailed to show that applicant was in possession of the claimed invention as a whole. ... “[D]rawings alone may provide a ‘written description’ of an invention as required by Sec. 112” Applicants submit that FIG. 2a, for example, provides a sufficiently detailed drawing to show that Applicants were in possession of the subject matter recited in Claim 50.

Therefore, withdrawal of the rejection is respectfully requested.

Rejection Under 35 U.S.C. § 112, Second Paragraph

Claims 42, 48-50, 55 and 61 stand rejected under 35 U.S.C. § 112, second paragraph. The reasons for the rejection are stated on page 3 of the Official Action.

As explained above, the term “optional” has been deleted in Claim 42.

Regarding Claim 50, the Official Action asserts that it unclear how a single third gas line is in fluid communication with the first gas line and the second gas line. In the exemplary embodiment of the gas injector shown in FIG. 2a, the “third gas line” 32 is in fluid communication with the “first gas line” in which flow controller 36a is placed, and the “second gas line” in which flow controller 36b is placed, via the T-connector 34. Applicants submit that one having ordinary skill in the art would be

able to understand the meaning of Claim 50 in view of the specification and drawings.

Therefore, withdrawal of the rejection is respectfully requested.

Claim Amendments

Independent Claims 7, 9, 10 and 41 have each been amended to recite “a common gas supply in fluid communication with a first gas line and a second gas line, the first gas line being in fluid communication with the on-axis outlet but not with the off-axis outlets and the second gas line being in fluid communication with the off-axis outlets but not with the on-axis outlet.” Independent Claim 42 has been amended to recite “a common gas supply in fluid communication with the first gas passage and the second gas passage.” In other words, embodiments of the claimed plasma processing system can provide a common gas to different outlets not in fluid communication with each other, e.g., both an on-axis outlet and off-axis outlets. As explained below, the references that have been applied in the different grounds of rejection do not suggest the combinations of features recited in the independent claims.

First Rejection Under 35 U.S.C. § 103

Claims 1-7, 9, 11-14, 39, 41-50 and 56-61 stand rejected under 35 U.S.C. § 103(a) over WO 99/57747 to Chang (“Chang”) in view of U.S. Patent No. 6,450,117 to Murugesh et al. (“Murugesh”) and U.S. Patent No. 5,958,140 to Arami et al. (“Armani”), or U.S. Patent No. 5,532,190 to Goodyear et al. (“Goodyear”), or U.S.

Patent 6,090,210 to Ballance et al. ("Ballance"). The reasons for the rejection are stated on pages 4-9 of the Official Action. The rejection is respectfully traversed.

Initially, Claims 46 and 59 each depend from Claim 10. However, Claim 10 has not been rejected under this ground of rejection. Accordingly, the rejection of Claims 46 and 59 is improper and thus should be withdrawn.

Claim 1 recites a plasma processing system, which comprises, *inter alia*, "a plasma processing chamber; ... a dielectric member having an interior surface facing the substrate support, wherein the dielectric member forms a wall of the processing chamber; a gas injector extending through the dielectric member, the gas injector comprising a body including an axial end surface exposed within the processing chamber, a side surface extending axially from the axial end surface, and a plurality of gas outlets including at least one on-axis outlet in the axial end surface and a plurality of spaced-apart off-axis outlets in the side surface; a common gas supply in fluid communication with a first gas line and a second gas line, the first gas line being in fluid communication with the on-axis outlet but not with the off-axis outlets and the second gas line being in fluid communication with the off-axis outlets but not with the on-axis outlet" (Emphasis added).

FIG. 2a shows an exemplary embodiment of a portion of a plasma processing system including a dielectric member 20 having an interior surface (the bottom surface), and a gas injector 22 extending through the dielectric member 20. The gas injector comprises a body including an axial end surface (the bottom surface) and a side surface, which extends from the axial end surface. An on-axis outlet 24 is provided in the axial end surface, and plurality of spaced-apart off-axis outlets 26 are provided in the side surface. As also shown in FIG. 2a, a common gas supply is in

fluid communication with both a first gas line and a second gas line. The first gas line is in fluid communication with the on-axis outlet 24 but not with the off-axis outlets 26, and the second gas line is in fluid communication with the off-axis outlets 26 but not with the on-axis outlet 24.

The Official Action asserts that Chang discloses “the invention substantially as claimed,” including:

a gas injector extending through the dielectric member such that a distal end of the gas injector body is exposed within the processing chamber and comprising a plurality of gas outlets 96/98 including at least one on-axis outlet 96 in the axial end surface and a spaced-apart off-axis outlet in the side surface. (Emphasis added).

The Official Action admits that Chang “does not expressly disclose that the plurality of gas outlets includes at least one on-axis outlet in the axial end surface and a plurality of spaced-apart off-axis outlets in the side surface” (page 5, lines 12-14 of Official Action; emphasis added). However, it is asserted in the Official Action that Murugesh cures this deficiency of Chang.

The Official Action also admits that Chang and Murugesh fail to disclose a common gas supply in fluid communication with a first gas line and a second gas line (page 6, lines 7-8 of Official Action). However, the Official Action asserts that Arami, Goodyear or Ballance cures this deficiency of Chang and Murugesh.

Applicants disagree with these assertions. FIG. 7 of Chang shows a top gas nozzle 96 extending through an opening in dome 50, and a top vent 98 supported on the upper surface of the dome. As shown in FIG. 1 of Chang, the top gas nozzle 96 is in fluid communication with the gas source 100a, while the top vent 98 is in fluid communication with the different gas source 100b. The top gas nozzle 96 and top vent 98 are not in fluid communication with a common gas supply.

The Official Action has asserted that Chang discloses a "body" comprising both the top gas nozzle 96 and the top vent 98. However, the Official Action has failed to identify the location of any alleged "side surface" in the "body." For example, the gas nozzle 96 does not include "a side surface extending axially from the axial end surface" that includes even one off-axis outlet in such side surface, much less "a plurality of spaced-apart off-axis outlets in the side surface," as recited in Claim 1. To the extent that Chang discloses a concentric tube arrangement including a central tube with a flared opening surrounded by a wider body, there are at most two outlets connected to different respective gas sources.

Murugesh fails to cure the deficiencies of Chang regarding the system recited in Claim 1. The Official Action asserts that Murugesh discloses an apparatus comprising a gas injector, which comprises a body including an axial end surface, a side surface extending axially from the axial end surface, and at least one on-axis outlet 85 in the axial end surface and a plurality of circumferentially spaced-apart off-axis outlets 247 in the side surface. It is further asserted that it would have been obvious to modify the apparatus of Chang to comprise the gas injector disclosed by Murugesh "in order to optimize the delivery of gas(es) into the chamber and in order to direct gas preferentially across a surface of the chamber." These assertions are not supported by Murugesh.

The embodiment of the gas distributor 215 shown in FIGs. 2A and 2B of Murugesh includes an inlet 218 for receiving a cleaning gas, which is distributed to gas outlets 247 opening at the top surface. This structure does not include either "at least one on-axis outlet in the axial end surface" or "a plurality of spaced-apart off-axis outlets in the side surface," as recited in Claim 1.

As shown in FIG. 7, Chang's gas nozzle 96 and top vent 98 (having a co-axial flared tube arrangement) inject different gases 96a and 98a, respectively, downwardly toward a semiconductor substrate. In stark contrast, the gas distributor shown in FIG. 3 of Murugesh includes a first gas distributor 65 and second gas distributor 215, which include first gas outlets 85 and second gas outlets 247, respectively, arranged perpendicular to each other. A process gas 70 is supplied to the first gas outlets 85 from a first gas delivery system 60 and flowed downwardly to process a substrate. A different, cleaning gas is supplied to the second gas outlets 247 from a second gas delivery system 200 to clean the chamber (see the Abstract). The cleaning gas is introduced perpendicular to the direction of the first gas outlets 85 and toward the chamber 30 wall.

Contrary to the assertions set forth in the Official Action, Murugesh's structure would not "optimize the delivery of gas(es) into the chamber ... in order to direct gas preferentially across a surface of the chamber" (emphasis added). In fact, Murugesh's structure shown in FIG. 3 directs different gases, at different times, toward different surfaces (i.e., a substrate surface and an inner surface of the chamber wall) in order to achieve the different purposes of processing the substrate and cleaning the chamber using the different gas compositions.

Neither Chang nor Murugesh discloses a plasma processing system that includes a gas injector and a common gas supply for providing the same gas to separate gas lines that deliver the gas to on-axis and off-axis outlets of the gas injector. Accordingly, modifying Chang's apparatus to include the gas distributor of Murugesh would not result in the combination of features recited in Claim 1.

Murugesh's apparatus is operable such that after the process gas 70 has been introduced into the chamber to process a substrate 25, the process gas is exhausted from the chamber. Subsequently, a cleaning gas is supplied to a different gas outlet such that the cleaning gas is directed preferentially across a surface in the process zone, such as the ceiling. Murugesh's apparatus does not "optimize the delivery of gas(es) into the chamber ... in order to direct gas preferentially across a surface of the chamber" (emphasis added).

Thus, Murugesh provides no suggestion or motivation to modify Chang's apparatus in the manner advanced in the Official Action. Murugesh teaches away from the modification of Chang proposed in the Official Action. However, "a prior art reference must be considered in its entirety, i.e., as a whole, including portions that would have led away from the claimed invention" (citation omitted). See MPEP 2141.02, page 2100-127. The Official Action has failed to comply with this requirement, but has selectively picked and chosen disclosure from Murugesh while ignoring portions of Murugesh that would have led away from the subject matter recited in Claim 1. However, even with impermissible hindsight, Chang and Murugesh cannot be combined in a manner that achieves the claimed system.

Arami, Goodyear and Ballance fail to provide any motivation to further modify Chang's apparatus, as modified to include Murugesh's gas distributor structure. The Official Action asserts that Arami, Goodyear or Ballance disclose gas injecting systems that comprise the features of "a common gas supply in fluid communication with a first gas line and a second gas line, the first gas line being in fluid communication with the on-axis outlet but not with the off-axis outlets and the second gas line being in fluid communication with the off-axis outlets but not with the on-axis

outlet,” as recited in Claim 1, and that it would have been obvious to modify the gas supply system of the Chang/Murugesh apparatus to include such gas injecting systems. Applicants disagree with these assertions.

Chang and Murugesh both teach away from a plasma processing system that includes a common gas supply to supply a common gas to an on-axis outlet and off-axis outlets of a gas injector. Murugesh teaches that different gas supplies are required in the apparatus to process a substrate with one gas and then to clean the chamber with another gas. Moreover, Murugesh does not suggest that the arrangement of gas outlets 85 and 247 shown in Fig. 3 would be suitable to supply a common gas from a common gas supply. Therefore, modifying the Chang/Murugesh apparatus to include a common gas supply in fluid communication with the first gas outlets 85 and the second gas outlets 247 would make the Chang/Murugesh structure inoperable for its intended purpose. As such, there is no suggestion or motivation to make the modification advanced in the Official Action. See MPEP § 2143.01, page 2100-131.

For the foregoing reasons, Claim 1 is patentable over the applied combination of references.

Dependent Claims 2-6, 11, 13, 14, 39, 43, 50 and 56 also are patentable over the applied references for at least the same reasons as those discussed above regarding Claim 1. Moreover, these dependent claims recite additional combinations of features that further patentably distinguish the claimed subject matter over the applied references. For example, Claim 5 recites that “the injector body is cylindrical shaped and the off-axis outlets are circumferentially spaced apart.” In contrast, Murugesh’s gas distributor shown in FIG. 3 does not have a cylindrical shaped body.

Claim 39 recites the features of "the on-axis outlet and the off-axis outlets are oriented at different angles relative to an exposed surface of the substrate." As explained above, Murugesh's first gas outlets 85 and the second gas outlets 247 are not oriented toward a surface, much less toward an exposed surface of a substrate.

Independent Claim 7 recites a plasma processing system, which comprises, *inter alia*, a plasma processing chamber; ... a dielectric member having an interior surface facing the substrate support, wherein the dielectric member forms a wall of the processing chamber; a gas injector extending through the dielectric member such that a distal end of the gas injector is exposed within the processing chamber, the gas injector including a planar axial end face having an on-axis outlet therein and a conical side surface having off-axis outlets therein, the on-axis outlet receiving process gas from a central passage in the injector and the off-axis outlets receiving process gas from an annular passage surrounding the central passage, ... a common gas supply in fluid communication with a first gas line and a second gas line, the first gas line being in fluid communication with the on-axis outlet but not with the off-axis outlets and the second gas line being in fluid communication with the off-axis outlets but not with the on-axis outlet" (Emphasis added).

As explained above, neither Chang nor Murugesh suggests a plasma processing system that includes a common gas supply, or a gas injector having a conical side surface with off-axis outlets in the side surface, as claimed.

Arami, Goodyear and Ballance each disclose a showerhead-type gas injection arrangement. For example, see FIG. 2 of Arami, FIG. 1 of Goodyear and FIG. 1 of Ballance. Accordingly, these references each fail to suggest a gas injector including a planar axial end face having an on-axis outlet therein and a conical side surface

having off-axis outlets therein. Moreover, these references fail to suggest modifying the Chang/Murugesh modified apparatus to include "a common gas supply ... the off-axis outlets but not with the on-axis outlet," as claimed.

Therefore, Claim 7 also is patentable over the applied references.

Dependent Claims 44 and 57 also are patentable over the applied references for at least the same reasons as those discussed above regarding Claim 7.

Independent Claim 9, as amended, recites a plasma processing system, which comprises, *inter alia*, "a plasma processing chamber; ... a dielectric member having an interior surface facing the substrate support, wherein the dielectric member forms a wall of the processing chamber; a gas injector extending through the dielectric member such that a distal end of the gas injector is exposed within the processing chamber, the gas injector including at least one on-axis outlet which injects process gas in an axial direction perpendicular to a plane parallel to an exposed surface of the substrate and off-axis gas outlets which inject process gas at an acute angle relative to the plane parallel to the exposed surface of the substrate, the off-axis outlets being circumferentially spaced apart from each other, ... a common gas supply in fluid communication with a first gas line and a second gas line, the first gas line being in fluid communication with the on-axis outlet but not with the off-axis outlets and the second gas line being in fluid communication with the off-axis outlets but not with the on-axis outlet" (Emphasis added).

Neither Chang nor Murugesh suggests at least "a common gas supply in fluid communication with a first gas line and a second gas line, the first gas line being in fluid communication with the on-axis outlet but not with the off-axis outlets and the

second gas line being in fluid communication with the off-axis outlets but not with the on-axis outlet.”

Furthermore, each of Arami, Goodyear and Ballance fails to cure the deficiencies of Chang and Murugesh regarding the combination of features recited in Claim 9. Therefore, Claim 9 also is patentable over the applied references.

Dependent Claims 45, 49 and 58 also are patentable over the applied combination of references for at least the same reasons as those discussed for Claim 9.

Independent Claim 41 recites a plasma processing system, which comprises, *inter alia*, “a plasma processing chamber; ... a dielectric member having an interior surface facing the substrate support, the dielectric member forming a wall of the processing chamber; a gas injector body extending through the dielectric member such that a distal end of the gas injector body is exposed within the processing chamber, the gas injector body including a plurality of gas outlets which are disposed within the processing chamber below the interior surface of the dielectric member; a common gas supply ... the off-axis outlets but not the on-axis outlet; flow controllers providing adjustable flow rates of process gas between at least some of the outlets into the processing chamber” (Emphasis added).

For reasons stated above, the applied references fail to suggest the combination of features recited in Claim 41, including at the least the features of “a common gas supply ... the off-axis outlets but not the on-axis outlet.” Therefore, Claim 41 also is patentable over the applied references.

Dependent Claims 47 and 60 also are patentable over the applied references for at least the same reasons as those discussed regarding Claim 41.

Independent Claim 42 recites a plasma processing system, which comprises, *inter alia*, “a plasma processing chamber; ... a dielectric member having an interior surface facing the substrate support, the dielectric member forming a wall of the processing chamber; a gas injector comprising an injector body including at least first and second gas inlets, at least first and second gas passages, an axial end surface, a side surface extending from the axial end surface toward the interior surface of the dielectric member, and at least a first gas outlet in the axial end surface and a plurality of second gas outlets in the side surface at locations between the axial end surface and the interior surface of the dielectric member, the first gas passage being in fluid communication with the first inlet and first outlet, and the second gas passage being in fluid communication with the second inlet and second outlet, the first and second gas passages not being in fluid communication with each other; a common gas supply in fluid communication with the first gas passages and the second gas passages; flow controllers providing independently adjustable flow rates of gas through the first and second outlets” (Emphasis added). For reasons stated above, Claim 42 also is patentable over the applied combination of references.

Dependent Claims 48 and 61 also are patentable over the applied combination of references for at least the same reasons as those discussed above regarding Claim 42.

Therefore, withdrawal of the rejection is respectfully requested.

Second Rejection Under 35 U.S.C. § 103

Claims 8, 10 and 40 stand rejected under 35 U.S.C. § 103(a) over Chang in view of Murugesh and Arami, or Goodyear, or Ballance et al. (“Ballance”) and further

in view of WO 00/41212 to Ni et al. ("Ni"). The reasons for the rejection are stated on page 9 of the Official Action. The rejection is respectfully traversed.

Claim 8 depends from Claim 1. The Official Action admits that Chang, Murugesh, Arami, Goodyear and Ballance fail to suggest the features of "the gas injector is removably mounted in the dielectric window and supplies process gas into a central region of the chamber," as recited in Claim 1. However, the Official Action asserts that Ni discloses these features and that it would have been obvious to modify Chang's apparatus to include them.

Applicants submit that Murugesh's gas injector shown in FIG. 3 is not configured to be removable from a dielectric window.

Furthermore, Ni fails to cure the above-described deficiencies of Chang with respect to the subject matter recited in Claim 1. At the least, Ni also does not suggest a gas injector "comprising a body including an axial end surface exposed within the processing chamber, a side surface extending axially from the axial end surface, and a plurality of gas outlets including at least one on-axis outlet in the axial end surface and a plurality of spaced-apart off-axis outlets in the side surface," as recited in Claim 1. Thus, Claim 8 also is patentable.

Independent Claim 10 recites a plasma processing system, which comprises, *inter alia*, "a plasma processing chamber; ... a dielectric member having an interior surface facing the substrate support, wherein the dielectric member forms a wall of the processing chamber; a gas injector removably mounted in an opening in the dielectric member and extending through the dielectric member such that a single distal end of the gas injector is exposed within the processing chamber, a vacuum seal being provided between the gas injector and the dielectric window, the gas

injector including a plurality of gas outlets in the single distal end which are each located below the interior surface of the dielectric member, a common gas supply" (Emphasis added). Claim 10 is also patentable.

Dependent Claim 40 is also patentable for at least the same reasons as those stated for Claim 10.

Therefore, withdrawal of the rejection is respectfully requested.

Third Rejection Under 35 U.S.C. § 103

Claim 15 stands rejected under 35 U.S.C. § 103(a) over Chang in view of Murugesh and Arami, or Goodyear, or Ballance et al. ("Ballance") and further in view of U.S. Patent No. 6,287,643 to Powell et al. ("Powell"). The reasons for the rejection are stated on page 10 of the Official Action. The rejection is respectfully traversed.

Claim 15 depends from Claim 1. The Official Action asserts that Powell discloses an electrically conducting shield and that it would have been obvious to modify Chang's apparatus to include such shield. However, Powell also fails to cure the above-described deficiencies of Chang with respect to the subject matter recited in Claim 1. At the least, Powell also does not suggest a gas injector "comprising a body including an axial end surface exposed within the processing chamber, a side surface extending axially from the axial end surface, and a plurality of gas outlets including at least one on-axis outlet in the axial end surface and a plurality of spaced-apart off-axis outlets in the side surface," as recited in Claim 1. Thus, Claim 15 also is patentable.

Therefore, withdrawal of the rejection is respectfully requested.

Fourth Rejection Under 35 U.S.C. § 103

Claims 51-55 stand rejected under 35 U.S.C. § 103(a) over Chang in view of Murugesh and Arami, or Goodyear, or Ballance, and further in view of U.S. Patent No. 4,270,999 to Hassan et al. ("Hassan"). The reasons for the rejection are stated on page 11 of the Official Action. The rejection is respectfully traversed.

Claims 51-55 depend from Claims 1, 7, 9, 41 and 42. The Official Action admits that Chang, Murugesh, Arami, Goodyear and Ballance fail to suggest on-axis and off-axis outlets that include an interior orifice contoured to provide sonic or supersonic flow therethrough. However, the Official Action asserts that Hassan cures this deficiency.

Applicants submit that Hassan fails to cure the above-described deficiencies of Chang and the other applied references with respect to the subject matter recited in independent Claims 1, 7, 9, 41 and 42. Thus, Claims 51-55 also are patentable.

Therefore, withdrawal of the rejection is respectfully requested.

Conclusion

For the foregoing reasons, allowance of the application is respectfully requested. Should the Examiner have any questions regarding this response, Applicants' undersigned representative can be reached at the telephone number given below.

Respectfully submitted,

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